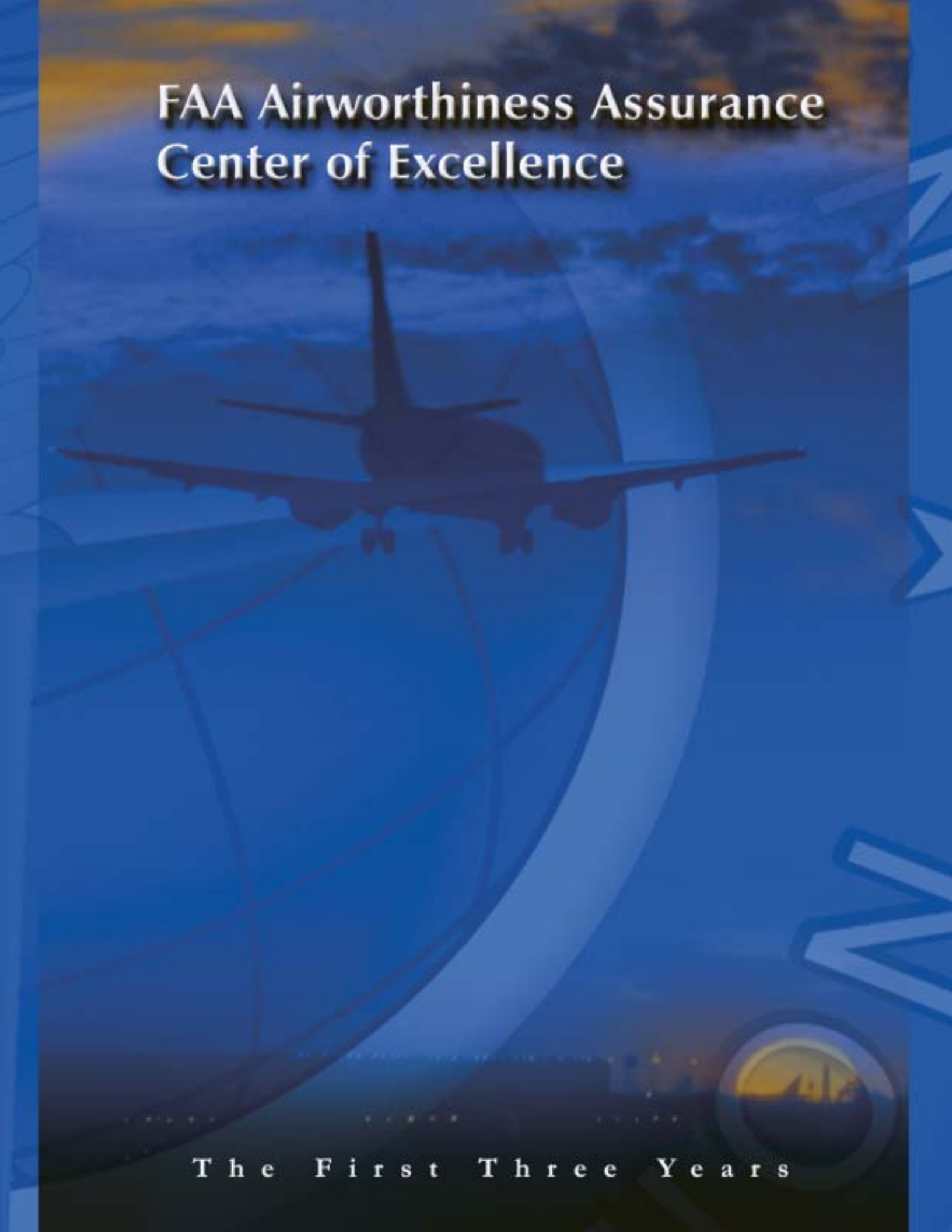
FAA Airworthiness Assurance Center of Excellence



The First Three Years

MESSAGE FROM THE ADMINISTRATOR

The Federal Aviation Administration's mission is to provide a safe, secure, and efficient aerospace system. To accomplish this mission, the agency promotes academic and industry partnerships. This addresses our research needs as well as helps to leverage our R&D budget.

With the Air Transportation Centers of Excellence (COE) for aviation research, the FAA supports the sharing of knowledge and is positioned for receiving and transferring emerging aviation technologies to the federal and private sectors. Participating universities also benefit through enhanced research programs that increase revenues for the institutions and enrich the educational opportunities for students.

Since 1992, the FAA has created five significant partnerships with world-class academic institutions and their industrial, state, and local government affiliates.

Created in September 1997, the largest COE was established to focus on Airworthiness Assurance (AACE) with a team of more than 100 academic, industry, and government partners. This Center of Excellence is dedicated to the entire range of aircraft safety research and the application of that research to solving current and predicted problems.

AACE has recently completed Phase I research activities. This report highlights the results of these initial efforts and introduces the projects and the people.

I commend the AACE partners and affiliates for their achievements during their first three years and look forward to their continued success in Phase II.

Jane F. Garvey
Administrator, Federal Aviation Administration

Airworthiness Assurance Center of Excellence (AACE)

The FAA is re-engineering how they do business, and one major effort that the agency has undertaken that represents this concept is the Airworthiness Assurance Center of Excellence (AACE). AACE is a multi-institutional, multi-disciplinary team established by the FAA to address research, education, and technology transfer in the area of airworthiness assurance. The Center was initiated in September 1997 with a team of universities with co-leads: Iowa State University and the Ohio State University. Other core member universities were Arizona State University, Northwestern University, University of California-Los Angeles, University of Dayton, University of Maryland, and Wichita State University.

In today's competitive market, the agency realized that the best way to investigate and resolve aviation safety issues was to build a team of knowledge that was different from all the rest, a team that made the difference between the ordinary and the extraordinary. This team combines the best of not one, not two, but three pools of knowledge: government, academia, and private industry. Bringing together this combination of state-of- the art expertise leads to one result: success.

Today, more than ever, the focus is on aviation safety, and that's the mission of AACE.

To realize that mission, AACE uses grant and contract dollars to uncover revolutionary breakthroughs in aviation safety. This unique Center has attracted world-renowned talent that addresses research, education, and the transfer of technology in the following areas of aviation safety:

- **Inspection, Maintenance and Repair**
- **Propulsion and Fuels**
- **Advanced Materials**
- **Crashworthiness**
- **Structural Integrity and Flight Loads**

AACE Benefits

The overall benefits that AACE has yielded in its first three years of operation have been monumental. AACE is shaping aviation safety from start to finish, with activities that run the full gamut from when something in the aviation industry is built, to when it is used, to when it is inspected, to when it is repaired. The information uncovered by AACE research is invaluable, leading to solutions to make our skies safer everyday.

Increasing Aviation Safety for Tomorrow

By having academia as part of its team, AACE doubles its value by serving as a training ground for top students who receive practical, hands-on training where they learn by doing. This not only builds motivation, but also gives the students a clear advantage when they graduate and address the aviation safety needs of the future. Numerous companies have benefited greatly by hiring an already trained expertise that can hit the ground running when it comes to researching and solving aviation safety issues. Students have participated in all tasks in AACE; nearly 100 students have benefited from the opportunity to work on FAA research projects.

Working With The Best To Make A Quality Product

By having private industry as a participant, AACE has had experts from over 50 of the pre-eminent companies in the aviation industry such as American Airlines, Boeing, Lockheed Martin, Raytheon Aircraft Co., and Pratt & Whitney, to name a few, participating in examining new ways of doing things and making unprecedented breakthroughs in aviation safety. The involvement of industry has led to better products and processes that have enhanced how aviation products are built, inspected, and repaired.

Enhancing Other Technological Efforts

A primary mandate of AACE is to share their state of the art findings. AACE research has produced over 150 publications and 19 student theses that contain a wealth of information and an abundance of findings. The publication of this information enables others to apply this knowledge towards their work or technological efforts. Additionally, conferences are held annually that allow the AACE team experts to present their results to others interested in aviation safety in government, academia, and private industry.

The laboratories that are associated with AACE also bring state of the art facilities to bear on critical issues in aviation safety. The FAA Airworthiness Assurance Nondestructive Inspection Validation Center (AANC) provides a realistic environment for developers to test and validate new maintenance and inspection technology. This provides the academic researchers a venue to transition their basic research to practical applications and provides equipment developers a testing ground for their new devices.

AACE Benefits

Helping To Make Aviation Products Safer

AACE researchers have provided technical support and engineering data to many of the key industry committees. These committees deal with industry standards and specifications that define methods and processes which are used in the manufacture, operation maintenance, repair and inspection of aviation products. And which renowned committees have we had the distinction of working with? Prominent ones like the American Society of Testing Materials (ASTM), the Society of Automotive Engineers (SAE) Committee K for NDT Aerospace Methods, the American Society for Nondestructive Testing (ASNT) Aerospace Committee, and the Commercial Aircraft Composites Repair Committee (CACRC).

Example of Aircraft Wiring

Accomplishments

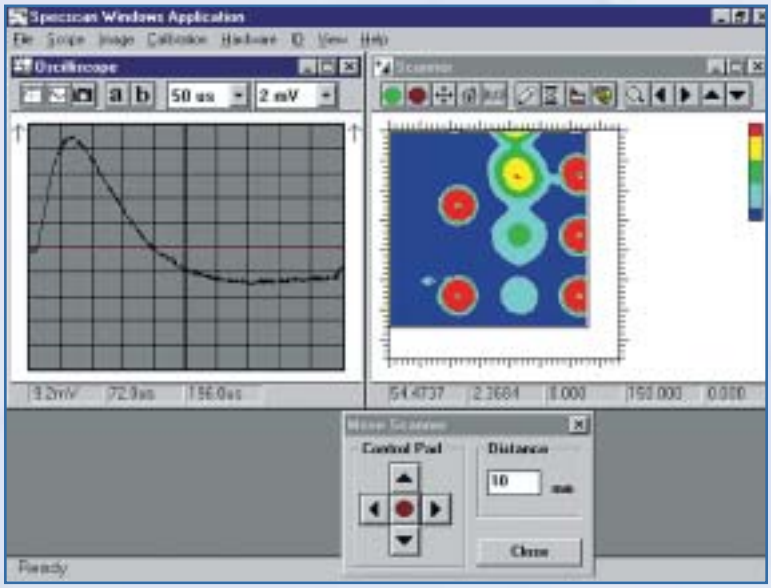
Over the Last Three Years

A Test-Bed Aircraft at FAA NDI Validation Center

Inspection, Maintenance, and Repair

The Inspection, Maintenance, and Repair area is a major focus of AACE research with over 23 tasks. Just like a car, aircraft need to be inspected at regular intervals to insure the equipment remains safe after time and use. All of this adds up to one thing: catching problems before they occur and cost lives. AACE researchers have investigated a number of advanced inspection technologies such as infrared detection, magneto-optical techniques, shearography, eddy current, and ultrasonics. By teaming with industry partners, these research developments were brought from the university laboratory to field applications as technology transfer continues to be a key component of AACE.

Accomplishments - Over the Last Three Years



Pulsed Eddy Current Inspection Display

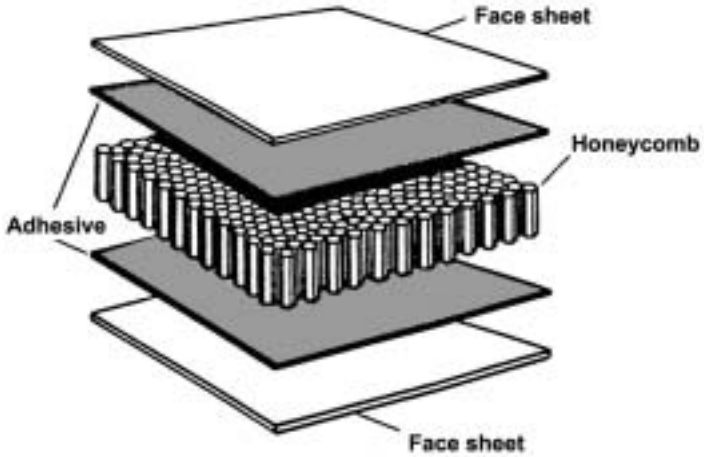
The detection of cracks in aircraft structures continues to a top priority in inspection research. Some of the progress made in enhancing crack detection techniques includes the development of a novel pulsed eddy current instrument that will better characterize cracks and locate them in the depth of the material being inspected. The enhanced technique can find defects at greater depths with increased accuracy with one measurement.

Other technologies for crack detection include ultrasonic techniques for characterizing cracks in structures with multiple layers; again hidden cracks are of major concern. Ultrasonic tools were developed and tested on applications of high priority for our industry partners, both the airframe manufacturers and the airline operators.

Another area of research is aging of aircraft wiring. The aging of non-structural systems such as wiring is a top priority for the FAA. The problem is acerbated since wire bundles are very difficult to inspect since the wires run to locations that are inaccessible. Additionally, interior wires cannot be examined without taking them apart and this action alone could cause damage, even if there was none to begin with! Ongoing efforts will develop tools that could help predict and detect critical area of wiring and its degradation. Then problems can be caught early and fixed.

Advanced Materials

In this area, AACE researchers have investigated a number of topics relevant to advanced composite materials that are more and more frequently used to build an aircraft.



Typical Composite Sandwich Structure

Accomplishments - Over the Last Three Years

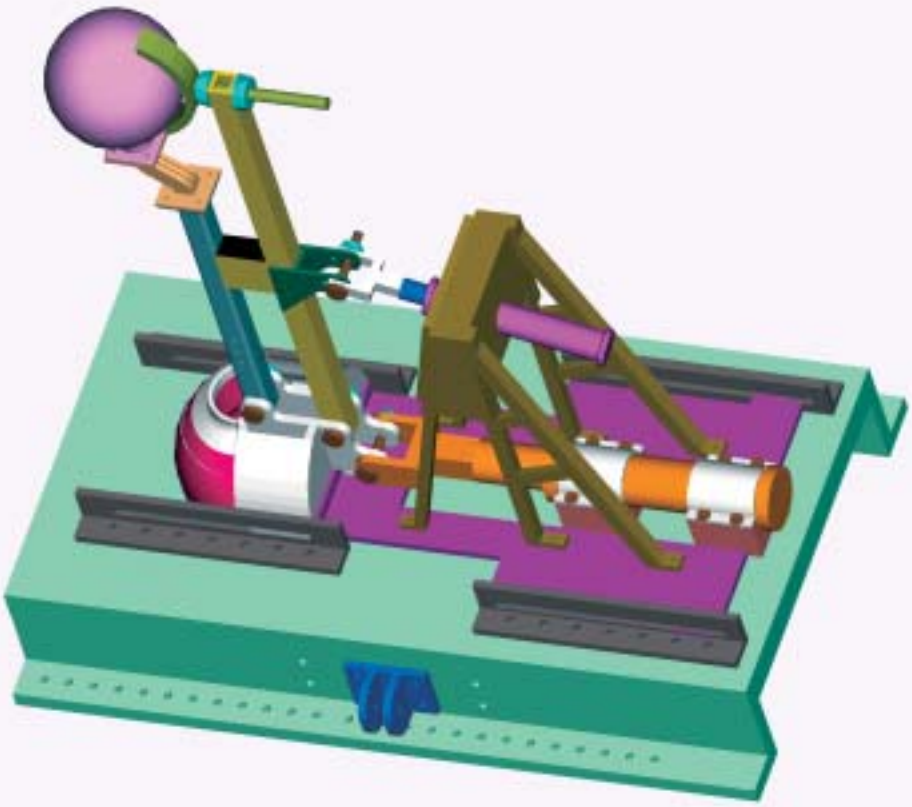
AACE researchers examined the effects of temperature on aircraft parts when they are glued together. AACE findings have been invaluable towards producing data that will assist in understanding the long term effects and reliability of using adhesive to hold together parts like the joints of an aircraft. And just how will this augment safety? When Advisory Circulars are written that provide users information like how thick or in what temperature should the adhesive be applied for aircraft, or when manufacturers certify aircraft built using adhesive, the data developed under AACE sponsorship will be crucial.

AACE researchers have also studied criteria that help determine damage to composite sandwich structures; especially if the damage is so small it cannot be seen. These structures are comprised of layers; just like a sandwich, hence the name. These types of structures are used in aircraft fuselages or helicopter wings.

Prior to this investigation, little-to-no data or guidance existed regarding the damage tolerance requirements for these sandwich structures. AACE research developed a handbook that has the dual benefit of supporting FAA certification decisions and providing data to industry to support their design processes.

Structural Integrity and Flight Loads

In this area, the main focus has been on determining how cracks start and how they grow. There were four tasks in this technical area. Two tasks were focused on developing analytical prediction methods for specific aviation applications, one task was experimental in nature, examining the generation and detection of small cracks in aircraft structures, and the final task developed methods to collect and analyze data on the actual loads the airplane experiences while in flight.



Schematic Drawing of Component Tester for Seat Tests

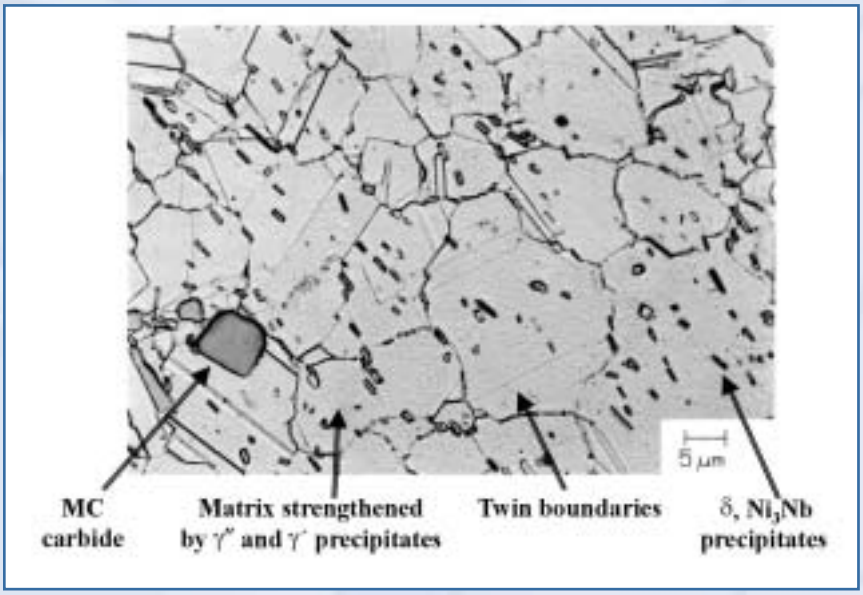
Software tools were developed for use by the rotorcraft industry in complying with planned FAA rulemaking. These tools were developed and validated in cooperation with end user, the rotorcraft industry, to insure the final product will meet both the needs of the FAA and the rotorcraft manufacturers and operators. Results from this research effort will also be used in the development of guidance material for the rotorcraft manufacturers to use to comply with the rulemaking. Another significant accomplishment was the collection of a substantial body of data on large transport aircraft currently in operation in the US; data which can be used by the FAA in making regulatory decisions, by the aircraft manufacturers in making design and continued airworthiness assessments on current and future aircraft, and by the airlines to assess current operational usage and maintenance procedures. This task was also done in close cooperation with the aviation industry, both the manufacturers and the operators.

Crashworthiness

In this area AACE research is focused on the safety of the aircraft occupants during a crash. New methods of testing were investigated so that when safer components (like the seats in the plane) get introduced, they can be tested faster and cheaper, yet with the same rigorous safety standards.

Currently all seats installed in airplanes must undergo testing to show that they will protect occupants in a crash; typically 15 to 25 tests for each new airplane seat configu-

Accomplishments - Over the Last Three Years



Microstructure of Forged and Heat Treated 718

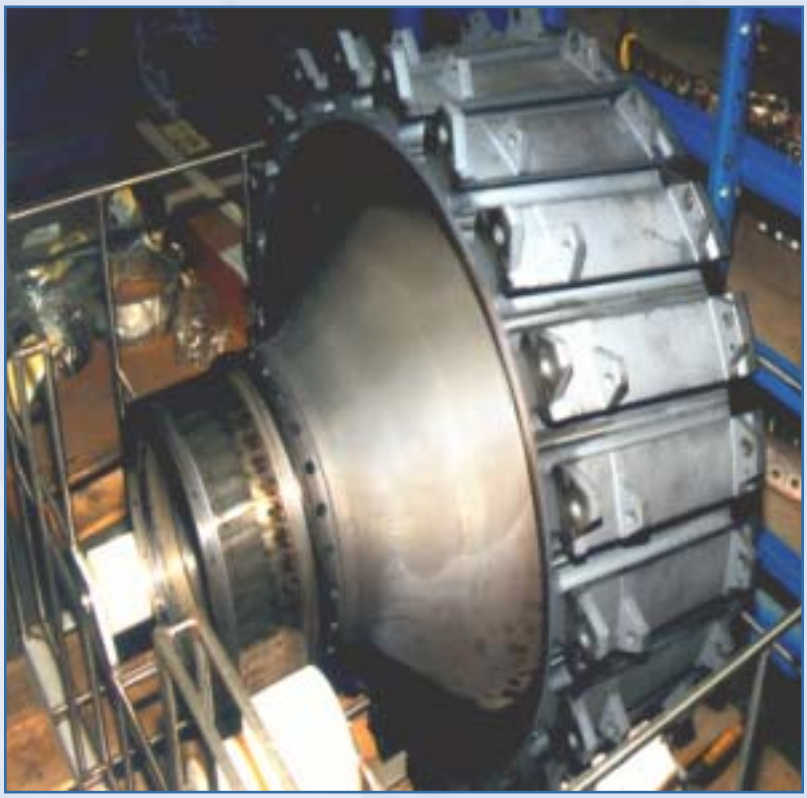
ration, each test requiring a new seat to be designed and manufactured. No wonder it is time consuming and costly. Therefore, to reduce the time and the cost, AACE developed a component tester. This device will be able to verify the seat configuration as a component test, as opposed to a full-scale certification test.

Propulsion and Fuels

In this area, AACE has begun to unlock significant finds towards the very essence of that which makes aircraft fly, the engines and the fuel that feeds them.

Teams of experts have started to investigate the properties of titanium, a metal that is used in critical engine components. AACE researchers are investigating a phenomenon called cold-dwell fatigue. There's suspicion that cracks in the metal invisible to the eye could occur in parts that are in the colder part of the engine. Thus the name cold dwell fatigue.

AACE is committed to doing what it takes to understand this phenomenon. Although this task has only been underway a year, substantial progress was been made. The ability of AACE to respond to this critical need of the FAA illustrates the responsiveness of the Center to FAA certification needs.



Engine Components Ready for Inspection

The Who's Who of AACE

Co-Lead Universities

Iowa State University

Ohio State University

Core Member Universities

Arizona State University
University of Dayton
Sandia National Laboratories
Northwestern University
University of Maryland
Wichita State University
University of California - Los Angeles

Academic Affiliates

Baylor University
Carnegie Mellon Research Institute
Columbus State University
Cornell University
Embry-Riddle Aeronautical University
Georgia Institute of Technology
Johns Hopkins University
Lehigh University
Massachusetts Institute of Technology
Mississippi State University
Northeastern University
Pennsylvania State University
Princeton University
Purdue University
Rutgers University
Stanford University
State University of New York at Buffalo
Tuskegee University
University of Akron
University of Alabama
University of Arizona
University of California - Irvine
University of California - Santa Barbara
University of Cincinnati
University of Connecticut
University of Florida
University of Kansas
University of Missouri-Columbia
University of North Dakota
University of Oklahoma
University of Utah
University of Wyoming
Vanderbilt University
Virginia Polytechnical Institute
Washington University
Wayne State University

Government and National Laboratory Affiliates

Air Force Institute of Technology
Brookhaven National Laboratory
Department of the Air Force
Idaho National Engineering Laboratories
Lawrence Livermore National Laboratory
NASA Langley Research Center
NASA Glenn Research Center
Air Force Research Laboratory - Wright Patterson Air Force Base
Iowa Air National Guard
Iowa Army National Guard

Industry Participants

Alaska Airlines
Allison - Rolls Royce
Allvac
American Airlines
ARINC
ATA NDT Working Group
Belden Wiring
Bell Helicopter
BF Goodrich
Boeing
CACRC
Carpenter
Cercast
Cessna
Cirrus Design
Delta Airlines
Dynamet
Experimental Aircraft Association
Fairchild
General Electric
Haynes
Hexcel
Hitchcock
Honeywell
Howmet
JENTEK Sensors Inc.
Krautkramer-Branson
Lancair
Lockheed Martin
Midwest Express
NORDAM
Northwest Airlines
Panametrics
PCC Structurals
Pratt and Whitney
Precision Rolled Products
PRI R&D Corp
Raytheon
RMI Titanium
SAE Committee K - NDE
SAE SEAT Committee
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Shultz Steel
Sikorsky
Simula
Special Metals
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